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Abstract

High rates of home births in developing countries are often linked to high rates of newborn deaths, but there is considerable debate about how much of this is causal. This paper weighs in on this question by analyzing data on the timing of birth, health care utilization, and mortality for a sample of births in 7,021 rural Nigerian households occurring between 2009 and 2014. First, we show that timing of birth is strongly linked to use of institutional care: women with a nighttime birth are significantly less likely to use a health facility because of the difficulties associated with accessing care at night. In turn, this is associated with a sharp increase in the rate of newborn mortality at night. Leveraging variation in household proximity to a health care facility that offers 24-hour coverage, we show that this increase in mortality is plausibly due to lack of formal health care at the time of birth: infants born at night to households without a nearby health care facility that offers 24-hour coverage, experience an increase in mortality equivalent to about 10 additional newborn deaths per 1,000 live births. In contrast, when households have a nearby health facility that provides care at night, there is no detectable increase in mortality. These results suggest that well-designed policies to increase access to (and quality of) formal care at birth will likely to lead to significant reductions in newborn deaths.

Key words: Nigeria; newborn mortality; access to care; childbirth; institutional delivery; formal care; sub-Saharan Africa

1 Introduction

There is an ongoing debate about the relative effectiveness of supply- and demand-side interventions in terms of reducing rates of newborn and maternal mortality in developing countries. The returns to institutional delivery is an important point of contention that lies at the heart of this debate. Notwithstanding the recent emphasis on shifting deliveries to institutional settings, there is little robust empirical evidence showing that use of health facilities at birth leads to lower newborn mortality (Chinkhumba et al., 2014). On the one hand, a large number of observational studies in low-to-middle income country settings suggest that institutional delivery has a moderate-to-large impact on newborn mortality (Tura et al., 2013), but on the other hand, rigorous evaluations of recently implemented demand-side interventions such as the Janani Suraksha Yojana program in India have found mixed results (Lim et al., 2010; Powell-Jackson et al., 2015).

We contribute to this debate by utilizing rich data that we collected on the timing of birth, use of institutional delivery, and newborn mortality in Nigeria. We use these data to quantifiably assess the importance of institutional care at birth, by asking what happens to the outcomes of newborn infants when events outside a mother's control 'force' her to give birth at home. Our empirical strategy relies on plausibly exogenous variation in the timing of birth for spontaneous deliveries. The importance of the timing of birth in this context is due to the fact that access to institutional health care varies systematically by time of day. Importantly it worsens at night: Not only is it harder for women to find safe transportation at night, but health facilities are more likely to be closed, and health providers less likely to be present. Because the timing of birth is a variable that is largely outside the control of women, it provides a natural experiment that allows us to assess the effect of institutional delivery on birth outcomes. In developing country settings, caesarean rates are very low (Betrán et al., 2016); as a result, most women do not know exactly when labor will start – it often comes as a surprise – and once it starts, it cannot be delayed until a more opportune time.

We find that women who give birth at night (between the hours of 8pm and 8am) are indeed significantly less likely to give birth in a health facility (there does not however appear to be any change in the rate of home deliveries attended by skilled providers). At the same time, we find a marked increase in the rate of newborn mortality for night births. Leveraging variation in household proximity to a health care facility that offers 24-hour coverage, we show that this increase in mortality is plausibly due to lack of formal health care at the time of birth. We find that infants born at night to households without a nearby health care facility that offers 24-hour coverage experience an increase in mortality equivalent to about 10 additional newborn deaths per 1,000 live births. In contrast, when households have a nearby health facility that provides care at night, there is no detectable increase in mortality. The results are robust to changes in sample restriction and model specification, and to the inclusion of an extensive set of controls. We discuss, and attempt to rule out, alternative explanations, including selection, and lower quality of care at night.

Our findings suggest that the returns to institutional delivery (at least in terms of newborn health) may be substantial, but given data limitations we are cautious about placing a causal interpretation on these findings. This paper should therefore be seen as a complement to the existing literature (for two recent contributions see Godlonton and Okeke, 2016; Daysal et al., 2015). Our results have clear policy implications: they indicate that while policies promoting institutional deliveries have the potential to improve newborn outcomes (see for example Feng et al., 2011), additional investments in improving health care availability and quality will likely prove necessary to unlock these benefits.

The rest of the paper is organized as follows: in Section 2 we provide some additional details about the study context and the data; in Section 3 we discuss our empirical strategy and present the results; in Section 4 we discuss the policy implications of these results, and in Section 5 we conclude.

2 Study setting and data

2.1 Study Setting

This study was carried out in Nigeria. Nigeria is of significant global health interest because it is one of five countries that together account for more than half of all newborn deaths worldwide (Lawn et al., 2014). Nationally, only about 36% of births take place in a health care institution (National Population Commission and ICF International, 2014). Primary health care facilities providing basic preventive and curative care (including maternal and child health services) serve as the point of entry for most individuals into the Nigerian health care system. In 2012, there were 30,098 primary health care facilities in Nigeria (90% of all health care facilities), 72.5% of which were public facilities.

2.2 Data

The data used in this paper come from a set of surveys that we conducted in 2014. Ethical approval for the study was granted by Institutional review boards at RAND, Aminu Kano Teaching Hospital, Nigeria, and the University of Nigeria Teaching Hospital, Nigeria. The study sample consists of 386 public sector primary health care facilities located in predominantly rural areas across 12 states, and 7,021 households with a birth within the preceding five years resident in the catchment or service areas of these health facilities. Two states each were randomly selected from each of the six geopolitical zones in Nigeria. Trained data collectors visited the health facilities to collect data on facility characteristics, and also visited approximately 20 randomly sampled eligible households in each catchment area to interview all female household members who reported giving birth within the last five years. They collected information about household and individual characteristics along with detailed information about each birth in the preceding five years, including use of antenatal care, place of birth, time of birth, whether the birth was normal or assisted, and the survival status of the infant.

Measurement error due to recall bias is an important consideration in this context given the self-reported nature of the data. This is less of a concern for mortality where we have good evidence that women are able to accurately recall newborn deaths, though with some tendency towards rounding (Beckett et al., 2001). To account for this we have extended the definition of newborn mortality out to 30 days, even though the strict clinical definition is a death within the first 28 days. Potential inaccurate reporting of time of birth is a concern and merits consideration. In countries like Nigeria, where only a small fraction of births is registered with civil authorities (skewed naturally towards mothers who gave birth in a health institution), the only way to therefore get broadly representative information about timing of birth is by asking mothers. Based on our pilot findings we asked women to choose from several broad time intervals: 8am-12pm, 12-4pm, 4-8pm, 8-11pm, 11pm-1am, 1-3am, 3-5am, and 5-8am (see Figure 1). To the extent that any measurement error is classical in nature, it will tend to attenuate the estimated effect of a nighttime birth (i.e., our estimate will be a lower bound). To address this potential issue, we have restricted the sample for the main analysis to include only the most recent birth for each woman (although we also show that our results do not hinge on this restriction) and as a further sensitivity check we show that the results hold when we further restrict the sample to focus on only births within the last two years.

Another source of error is from potential misclassification. Given differences in duration of labor, some women who gave birth at night may have started laboring in the daytime and thus faced daytime access conditions (in other words they should be classified as a daytime birth). Similarly, some women who gave birth in the daytime may have started laboring at night and faced nighttime access conditions.As we show later, any misclassification, if present, is not systematic, but to the extent that such misclassification is present, it will tend to attenuate our estimates. A third source of error arises from our recruitment strategy. To draw the required sample, we generated random starting points using GPS within each community, and trained enumerators went door-to-door to identify households with eligible women. As an anonymous reviewer has pointed out, women whose infants died might be less likely to report giving birth and would therefore be underrepresented in the sample. This was, however, something we were concerned about and so enumerators inquired about women who were pregnant at any time during the relevant period, in order not to miss women who did not have a live birth (or women whose infants died soon after birth). Despite this precaution, it is possible that we still missed some eligible women. If we assume that women missing from the sample are more likely to have a newborn death and also more likely to have had a nighttime birth (given that, as we show later, nighttime births are associated with higher mortality), then we likely are under-estimating the true mortality effect.

Descriptives

In total, we interviewed 7,103 eligible women and collected information for 9,428 births. In the analysis that follows, we restrict the sample to include only the most recent birth for each woman to mitigate concerns about accuracy of recall (on average women had 1.56 births over the sample period). We also exclude all assisted births (2% of the sample) because the timing of these births is unlikely to be exogenous (Spetz et al., 2001). Assisted births in our data are deliveries assisted by technological means, e.g., forceps, vacuum, or caesarean deliveries. Finally, as is standard practice in this literature we also exclude multiple births (2.4% of the sample). We show later that the results are not sensitive to these sample restrictions. The various sample restrictions leave us with a final sample size of 6,867 singleton births. Descriptives are in Table 1. We also present summary statistics for the health facilities included in the sample. In the Appendix we include a discussion of data representativeness by comparing our data to data from the 2013 Nigeria Demographic and Health Survey birth file [INSERT LINK TO ONLINE APPENDIX HERE].

3 Analysis

3.1 Timing of birth and use of facility care

We start by examining the relationship between the timing of birth and use of facility care at birth. We graph this relationship in Figure 2. As expected we see that there is a noticeable drop in use of facility care at night (between 8pm and 8am). We also graph the distribution of births attended by a formally-trained health provider (a doctor, nurse, midwife, or other community health worker) to show that the decrease in use of facility care is not compensated for by an increase in 'skilled' birth attendance at night. We see that both lines track each other quite closely indicating that this is in fact the case. We establish these results more rigorously in a linear regression specification where we control for a range of characteristics that may be correlated with a nighttime birth. The exact specification is:

$$Care_{ijmy} = \alpha + \beta Night_{ijmy} + \gamma \boldsymbol{X}_{ijmy} + \nu_j + \tau_{my} + \epsilon_{ijmy} \tag{1}$$

$Care_{ijmy}$ is a dummy indicator for a health facility birth for infant i born in community j in month m and year y. $Night_{ijmy}$ is a dummy variable that indicates whether the infant was born at night (defined as between 8pm and 8am). This follows the empirical evidence from Figure 2. $\boldsymbol{X_{ijmy}}$ is a vector of birth, maternal, and household characteristics. We control for the following characteristics: gender of the infant, prematurity (whether the baby was born before nine months), maternal risk (whether the mother had experienced a prior stillbirth), use of antenatal care, marital status, mother's age at the time of birth, mother's educational attainment (secondary education or higher) and literacy (whether she could read a simple sentence in English that was shown to her), ethnicity, and quintiles of household wealth. The latter was derived using principal component analysis from a vector of household assets. We include catchment area fixed effects to control for any fixed differences between service areas, and birth year x birth month time dummies to flexibly control for time trends. In alternative specifications we include catchment area-specific linear time trends. The standard errors are clustered at the catchment area level. In the Appendix we present robustness checks where we cluster standard errors at a higher administrative level; the local government authority or LGA. LGAs are smaller administrative units within a state that are responsible for overseeing primary health care facilities and there are 142 LGAs in our sample.

The regression results from Equation (1) are in Table 2. In Panel A, the dependent variable is use of institutional care at time of birth, and in Panel B, it is births attended by a formally-trained health worker. Column 1 reports the basic specification that includes only catchment area and birth year-birth month fixed effects but no additional controls. In Column 2 we add in the full vector of maternal, birth and household characteristics. In Column 3 we present results from a specification with catchment area-specific linear time trends. We obtain similar results with quadratic time trends (results not shown but available on request).

In general the results are similar across specifications and confirm that mothers who give birth at night are between 4.2-4.4 percentage points less likely to use institutional care at birth. The inclusion of additional controls does not significantly change the coefficient, suggesting that nighttime births are uncorrelated with other characteristics and circumstances of the mother and the pregnancy. In line with our observations based on Figure 2, the coefficients in Panels A and B are nearly identical, indicating that the reduction in facility care at night translates into a reduction in use of any skilled care. In Appendix Table A1, we present additional results showing average marginal effects estimated from random effects logit models that take into account the binary nature of the outcomes. Reassuringly, the results are similar to those from the linear models.

What explains this reduction?

Our rich survey data provide insight into why women who give birth at night are less likely to use facility care. In the survey we asked women who gave birth at home why they did not go to a health facility. They could choose from among the following responses: 'Cost too much', 'Facility not open', 'Facility too far', 'Poor quality service', 'No female provider', 'Not customary/family did not allow', 'Not necessary', and 'Other'. Keeping in mind that these are ex post responses, we tabulate means and standard deviations of the responses in Table 3 for daytime vs. nighttime births. We also test whether differences are statistically significant. The one notable difference is that women who gave birth at night were significantly more likely to report 'no transportation' as a reason why they did not use facility care.

Additionally, we asked women who gave birth at home whether the home delivery was planned, and we find that for nighttime births, women were significantly more likely (about 11 percentage points) to report that the home birth was not planned. These results are consistent with access constraints at night 'forcing' women to give birth at home. It also provides some evidence, as we have argued, that women are 'surprised' by the timing of the birth.

3.2 Timing of birth and mortality

Having shown that use of facility care decreases at night, and provided evidence consistent with access constraints, we turn our attention to the outcomes of these infants. In Figure 3 we graph the relationship between time of birth and newborn mortality (per 1,000 live births). To allow for easy comparison, we have superimposed on this, use of facility care at birth from Figure 2. The results are quite striking. We see that use of formal care at time of birth exhibits a U-shaped pattern over the 24-hour cycle (starting from midday); newborn mortality on the other hand follows a countercyclical inverse-U pattern that is almost exactly a mirror image.

We confirm the mortality result in Table 4 where we present results from the specification shown in Equation (1) where the dependent variable is newborn mortality (per 1,000 live births). We find that being born at night leads to an increase in newborn mortality of between 5.8 and 6.7 deaths per 1,000 live births (compared to an average mortality rate of 9.2 deaths per 1,000). The results are robust and retain their magnitude and significance across specifications. In Appendix Table A1, we again present average marginal effects from random effects logit models and show that the results are similar to the results from the linear specification.

The increase in mortality rates at night is plausibly a result of the reduction in the probability of receiving formal care at night. Before presenting some more evidence about this, it is necessary to consider and rule out any direct link between night births and these outcomes. While there is no biological basis for such a link (see (Smith, 2007) for a theoretical discussion of the physiology of timing of labor onset and Anderka et al. (2000) and Caughey et al. (2008) for empirical evidence), it is nonetheless true that in settings where interventional births such as caesarean births are common, the timing of birth is a choice that can result in daytime and nighttime births being quite different (Fabbri et al., 2016; Spetz et al., 2001). In most developing country settings (including ours), however, caesarean births account for only a small fraction of births (Betrán et al., 2016); moreoever, as we will show later, the inclusion or exclusion of these births from the analytical sample does not affect any of our results.

In our data we can formally test whether nighttime births are different from daytime births in terms of characteristics associated with mortality risk. The medical and epidemiological literature indicates that the following characteristics are associated with mortality risk: gender (male infants have higher risk), maternal age (younger and older mothers have higher risk), prior history of a stillbirth, prematurity, and use of antenatal care (Vogel et al., 2013; McMillen, 1979; Kozuki et al., 2013). In addition to these we include two other variables: the relative size of the baby at birth as reported by the mother (this is intended as a rough proxy for low birth weight – we create a dummy for infants reported to be small or very small at birth) and an indicator for whether the infant cried or breathed easily immediately after birth as reported by the mother. The latter is intended as a very rough proxy for the Apgar score, a widely used clinical measure of the status of a newborn infant immediately after birth (Casey et al., 2001). We also include a binary variable for whether the mother experienced any complications during the pregnancy as another proxy measure for risk.

We supplement these risk measures by constructing a maternal risk index that captures unobserved maternal risk factors. To construct this index, we estimated a "mortality production function", in which we regressed the mortality indicator on the vector of birth-specific characteristics as well as maternal fixed effects. The estimation takes advantage of the fact that many women in our sample had more than one birth during the recall period. The estimated maternal fixed effects can then be interpreted as a mother-specific index that captures variation in mortality which is not accounted for by the observed birth characteristics. In the mortality regression we overwhelmingly reject the null that these fixed effects are jointly equal to zero (p=0.000). Each of the risk characteristics above is then regressed on the indicator for night births, using the same regression specification as before.

Lastly, we test whether duration of labor is significantly different for daytime vs. nighttime births. This is also a way of validating our empirical strategy, which assumes that time of birth is not systematically correlated with duration of labor (θ). Though we do not have data on the precise duration of labor, we do have data on whether labor was prolonged (lasted for longer than 12 hours). Table 5 reports the results of these regressions. In line with our expectations, the coefficients are uniformly small and statistically insignificant in all the regressions. We are therefore reasonably confident that nighttime births do not fundamentally differ from daytime births.

Leveraging spatial variation in access to institutional care

To establish that the increase in mortality is attributable to the decreased use of facility care at the time of birth we leverage variation across households in proximity to a facility that provides health care services at night. Using data from our facility survey, we construct a measure of 24-hour coverage (defined as a health facility that is open 24 hours a day or has a health provider on site at night that can provide patient care). 30% of health facilities in our sample do not offer 24-hour services. It is important to point out that the primary care facility in the community is not the only health care facility available to households – households have access to other health facilities – however, the community facility *is* the closest, and as such one would expect this to be the facility of choice for most households (the mean distance to the community facility in our sample is 3 km; the median is less than 1 km). Consistent with this, 73% of all facility births in our sample take place in the community facility.

Where households have access to a nearby health facility that provides 24-hour services we do not expect to find significant differences between daytime and nighttime births in use of facility care. However where there is not a nearby health facility that provides coverage at night, we should find a significant decrease in use of facility care as women become more likely to substitute towards a home birth. This is in fact the case as Figure 4 clearly shows. In areas with a 24-hour facility, 72.2% of births take place in the health facility in the daytime vs. 71.9% at night. In contrast, in areas *without* a 24-hour facility, 65.8% of births take place in the health facility during the day compared to 53.2% at night – a 12.6 percentage point drop. If the increased mortality is due to decreased use of facility care, the increase in mortality should only show up in areas where health care access worsens at night, i.e., those where the local facility does not provide 24-hour coverage.

We start by presenting some descriptive results. In Figure 5 we disaggregate mortality (for daytime vs. nighttime births) by whether the household has a local health facility that provides

24-hour health care coverage. Once again, the results are quite striking. We notice two things: first, mortality rates for daytime births are nearly identical for households with/without a nearby 24-hour health facility, second, there is a large increase in mortality for nighttime births but only for households where the local facility does not provide 24-hour coverage. There is a slight uptick in mortality for nighttime births for households with a nearby primary care facility that provides 24-hour coverage but this is quite small. These results are exactly as predicted.

We confirm these descriptive results in Table 6. To allow the effects of the included covariates to flexibly differ between communities with/without a 24-hour primary health care facility, we estimate separate regression models for each sample. The results are similar across the various specifications and show that newborn mortality increases by between 12.8 and 13.3 deaths per 1,000 live births for infants born at night in communities with poor access to health care at night, i.e., where the local primary care facility does not provide 24-hour coverage. In contrast, in communities with a health facility that provides coverage at night, there is no detectable increase in mortality. In Appendix Table A2 we report results from a single fully interacted model that allows us to directly test whether the difference in mortality is statistically significant. The specification is:

$$\begin{aligned} Y_{ijmy} &= \alpha + \beta_0 Night_{ijmy} + \beta_1 Non\text{-}24\text{-}hr_j + \beta_2 Night{*}Non\text{-}24\text{-}hr_j + \boldsymbol{X}_{ijmy} \\ &\quad + \sum_{\delta} Non - 24 - hr_j {*} \boldsymbol{X}_{ijmy} + \nu_j + \tau_{my} + \epsilon_{ijmy} \end{aligned} \tag{2}$$

Non-24-hr denotes 24-hour health services coverage (for ease of interpretation we reverse the coding so that 0=Yes and 1=No). The coefficient on the interaction term (β_2) implies a differential increase in mortality of approximately 10 deaths per 1,000 live births for infants born at night in communities without a 24-hour facility. This coefficient is significant at the 10% level (p=0.07). In the second column we show that there is a corresponding (and symmetrical) differential decrease (about 7.4 percentage points) in use of formal care at the time of birth. These results hold in a specification where we interact the night birth indicator with all the included controls (results available on request).

3.3 Alternative mechanisms

In this section we discuss other potential mechanisms that could underlie the association between nighttime delivery and mortality. The first alternative we consider is that the increase in mortality could be due to lower quality of medical care at night. In other words, it is not because women are more likely to give birth at home, it is that women who go to a health care facility receiver lower quality care. Health care quality could worsen at night, for example, because of staffing changes or provider fatigue, leading to more errors (Luo and Karlberg, 2001). While our data does not allow us to directly test this mechanism, the results in Figure 5 and Table 6 indicate that this is unlikely to be an important factor. Notice that there is no significant increase in mortality between day and night for households with a nearby health facility that provides 24-hour services, as might be the case if worse quality of health care at night was driving the results.

A second hypothesis is that at night women face delays in receiving needed medical attention, which leads to worse outcomes (Thaddeus and Maine, 1994). There are several possibilities: (1) women who go to health care facilities at night experience delays in receiving care – for example because the provider is less likely to be present and has to be called from home; (2) women who give birth at home at night are not able to seek needed medical care in time if there is a complication; and (3) women who give birth in a primary care facility but then need more advanced care have to wait until morning to get to the higher-level facility. These delays could in theory contribute to the increase in mortality at night.

We can test the first mechanism, to some extent, in our data. In the survey we asked women who used facility care whether the health provider was present when they arrived at the health facility. We test whether women who gave birth at night were less likely to report that the health provider was present when they arrived. Interestingly, the results run in the opposite direction: women who gave birth at night were more (not less) likely to report that the health provider was present in the facility when they arrived. The point estimate is 2.4 percentage points and it is statistically significant at the 5% level (one potential explanation for this is that women only go to the health facility at night when they have good information that the health provider is likely to be there). We can therefore probably rule out this mechanism. We do not bother with the second mechanism because it is entirely consistent with the hypothesis being tested in this paper – that lack of proper care at the time of birth leads to worse outcomes. Unfortunately, our data does not allow us to rule out the third mechanism, but, again, the fact that the increase in mortality is concentrated in areas without a nearby clinic offering 24-hour services suggests that it is unlikely to be a major contributor.

A third hypothesis is that providers could try to "hurry up" deliveries later in the day to make sure they do not go on until late in the night, by augmenting labor for example (we thank the reviewer who made this point). This could then artificially change the composition of births at night. If this leads to more high-risk births taking place at night, this might help explain the association between nighttime births and mortality. While we have already shown that nighttime births are not systematically higher-risk, it is worthwhile to explore this further. An implication of this is that we should expect to see more deliveries in the late afternoon, and there is in fact some suggestive evidence of this in Figure 1. Under the assumption that this is likely to affect births later in the evening, we exclude births between 4 and 11pm. The reasoning is that some births that might otherwise have taken place between 8-11pm (making them a night birth) are shifted forward to 4-8pm (making them a daytime birth) so we exclude both of these and examine whether the results hold up. They do. These results are in Appendix Table 10.

Finally we examine whether the increase in mortality could be due to decreased use of postnatal care. Several studies have shown that infants born at home are less likely to receive postnatal care (Somefun and Ibisomi, 2016). If there is a causal link between use of facility care at birth and use of follow-up care, then nighttime births, by reducing the likelihood of a facility birth, may also reduce postnatal care use – a sort of 'domino' effect. If postnatal care matters for infant survival, then we could be picking up some of this effect. It is important to emphasize that this does not affect the conclusion that decreased use of health care at birth is responsible for the increased mortality, because even if the pathway is through postnatal care, this is itself a result of not using institutional care at birth (i.e., postnatal care lies along the causal pathway), but it does matter for interpretation. If the primary mechanism is decreased use of postnatal care then interventions to intensively follow-up women who give birth at home at night will help to offset the increased mortality. However, if the mortality is as a result of complications during/around childbirth, then such an intervention will have a limited effect.

To test this we first examine whether infants born at night are less likely to receive postnatal care.

We define a dummy indicating a postnatal visit within the first month. Postnatal care must have been provided by a formally-trained provider. A challenge here is that, as we have shown, infants born at night are more likely to die. Since dead children, by definition, cannot receive postnatal care, this may induce a mechanical negative correlation between nighttime births and postnatal care utilization. To account for, and to assess the potential importance of, this we re-estimate the results conditioning on surviving the first month. These results are in Table 7.

We find some evidence of a decrease in postnatal care utilization (Columns 1 and 2): nighttime births are about 2.1 percentage points less likely to receive a postnatal check-up, although these results are only significant at the 10% level. To explore the extent to which this might be driving our results, we examine whether the mortality result holds up when we focus only on mortality within the first 7 days. Since postnatal care is more likely to affect late neonatal mortality rather than mortality within the first few days, if we find similar results as with the main models this would indicate that the increase in mortality is likely due to lack of proper care at the time of birth (and not to follow-up care). In Column 3 of Table 7, we show that the results pass this test. In the Appendix we present disaggregated results by access to 24-hour care for early mortality and show that the results continue to hold.

3.3.1 Additional robustness checks

In the Appendix we present additional tables showing that the results are robust to various changes in variable definitions and model specification including: alternative definitions of a nighttime birth (between 11pm and 8am, and between 8am and 5am), restricting the sample to include only births within the last two years (under the assumption that women will be much less likely to mis-remember a recent birth), excluding premature and smaller-than-average sized infants (this group of infants have disproportionately higher rates of mortality), including assisted and multiple births, and clustering of standard errors at a higher level (at the level of the local government authority). [INSERT LINK TO ONLINE APPENDIX HERE]

4 Discussion

This paper has addressed the question of whether institutional deliveries can lead to reductions in newborn mortality. Using a newly available dataset that includes data on time of birth, service provision in nearby health facilities, and birth outcomes for a cohort of Nigerian infants, and exploiting variation in the timing of birth combined with variation in access to health institutions, we present evidence that lack of institutional care at birth plausibly leads to adverse impacts on newborn health. While the observed increase in mortality is plausibly due to (lack of) facility care, there are other factors associated with a nighttime birth that could also contribute to increased mortality at night. For example, even women who deliver in a health facility at night might end up experiencing a delay in receiving care – even more so in the case of non-24 hour areas, where women who do deliver in a facility have to travel further to access that care. We do our best to test some of these other channels but given data limitations are not able to completely rule them out. The results in this paper should therefore be interpreted as the effect of access to formal care at birth more broadly.

The estimated effect size is large relative to the average mortality rate in our sample. Back-of-the-envelope calculations, using our estimates, suggest that increasing 24-hour health facility coverage in our sample from 70% to 100% would reduce newborn mortality by about 33%. How does this compare to effect sizes for other newborn interventions? Jokhio et al. (2005) found that an intervention combining traditional birth attendant training with provision of home delivery kits resulted in a 29% reduction in newborn mortality. Gill et al. (2011) tested an intervention combining traditional birth attendant training (including specific training on neonatal resuscitation and management of neonatal sepsis) with provision of resuscitation equipment, antibiotics and home delivery kits and demonstrated a 45% reduction in newborn mortality. Baqui et al. (2008) showed that a community health worker home visitation program (during pregnancy and after delivery) reduced newborn mortality by 34%. Our estimate is therefore comparable to effect sizes obtained for other newborn interventions.

Another way to examine the plausibility of our estimates is to compare it to estimates from other papers that examine the same question. Godlonton and Okeke (2016) study the effect of a ban on traditional birth attendants in Malawi, and though they find that the resulting increase in facility births did not lead to a decrease in newborn mortality on average, they find that in one subset of households – those with access to a high-quality facility – it appeared to lead to a large decrease in mortality, similar in magnitude to that observed in this study. Daysal et al. (2015) also find large effect sizes, relative to average mortality in their sample, despite the fact that their sample consists of low-risk births. One potential reason for these large effect sizes is that the complier population (i.e., women who are deterred from delivering in a health facility by cost, distance, or time-of-day considerations) is at higher risk of adverse outcomes. One should also point out that confidence intervals usually include much smaller effects – a point also made by Daysal et al. (2015). Lastly, we note that the effect of facility care on mortality is going to be determined by the incremental difference in quality between home care and facility care. In settings where this difference is large, one should not be surprised to find large effects on newborn mortality. In our sample, for example, 1 in 3 home births had no attendant present (trained or untrained).

As always one should exercise caution in generalizing these results. On the one hand, Nigeria shares many similarities with other developing nations – problems with access to health care, for example, are not unique (Chaudhury et al., 2006) – suggesting that the results should generalize, but on the other hand, there are likely to be differences in the availability, quality, and distribution of health care resources and personnel that should be taken into account.

5 Conclusion

Reducing high rates of child mortality in developing countries is a global health priority, and since newborn deaths make up about 45% of all under-5 child deaths, this is an important target of policymakers (Liu et al., 2015). The findings in this paper are relevant for ongoing policy discussions about how to reduce high rates of infant and child mortality in low and middle-income countries. With the caveats we have noted, they present policy makers with a straightforward policy prescription for reducing child mortality – increasing 24-hour health facility coverage. Given that approximately half of all births occur at night, this is of non-trivial importance. Proper care at the time of birth has been emphasized in the literature as a key determinant for maternal and child survival, prompting large investments in various interventions designed to increase use of health institutions at time of birth (Glassman et al., 2013). On the one hand the results in this paper suggests that these policies can help to reduce newborn deaths, but on the other hand they underline the importance of addressing service delivery constraints and reinforce the point that focusing on increasing demand without improving the availability and quality of health care services is unlikely to deliver large reductions in mortality.

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